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(54) **Run-Flat Tyre and Wheel Assemblies**

(57) A safety tyre and wheel assembly of the type described in UK Patent Specification No. 1,522,028 is modified in that the elastomeric spacer rings 40, 42 are provided with annular reinforcements 44, 46 so as to be circumferentially inextensible but laterally elastic whereby the rings are compressible between the tyre beads 20, 22 and the bearing member 28 but radially outward displacement of the rings in use is prevented. The rotatable tyre support 38 may have a curved, as shown, or conic, surface 34 engaged with a corresponding surface 30 of the bearing member, and the latter may be made of molybdenum disulphide impregnated nylon. The support 38 and bearing member 28 may be formed by interconnected arcuate segments.

FIG.1

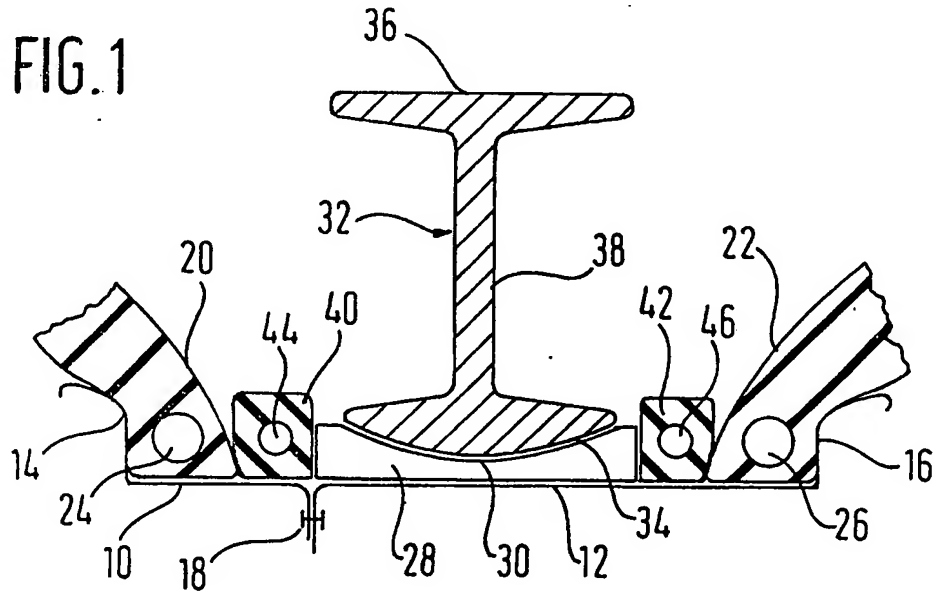

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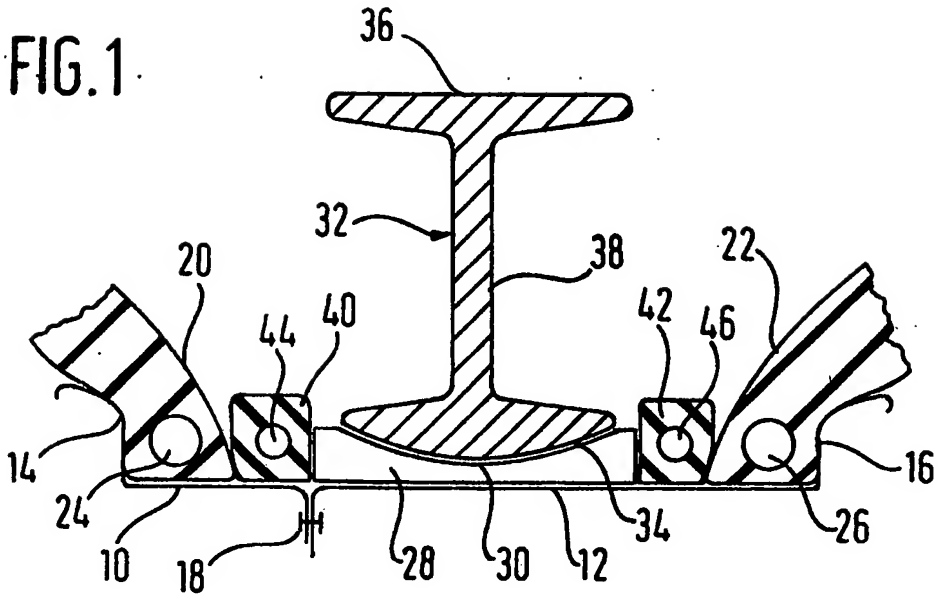
FIG.1



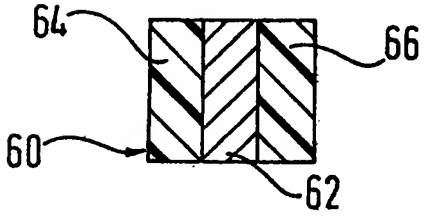


FIG.2

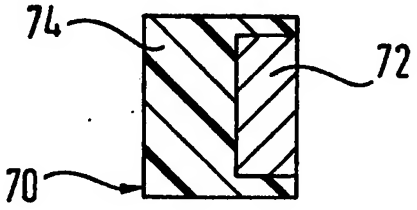


FIG.3

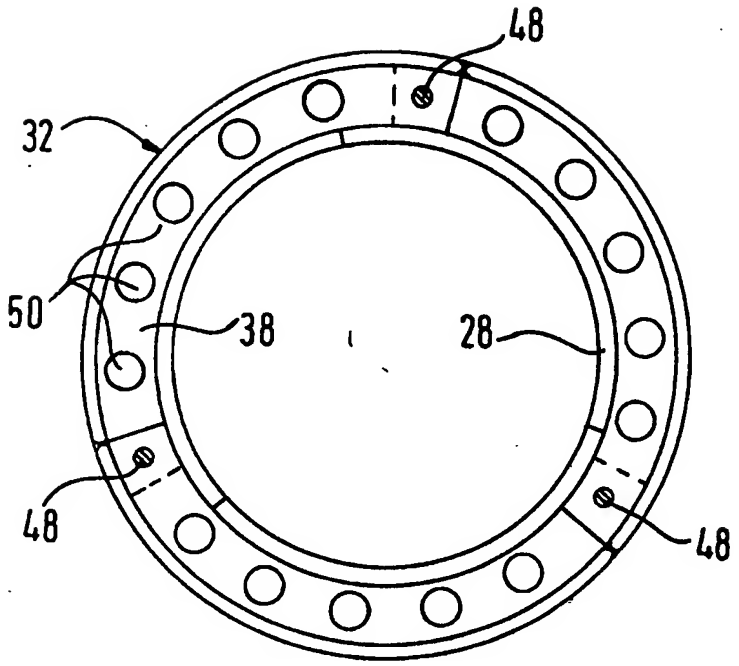
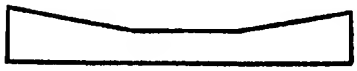


FIG. 4

FIG. 5 

FIG. 6 

SPECIFICATION

Improvements in or Relating to Tyre and Wheel Rim Assemblies

This invention relates to tyre and wheel rim assemblies.

It has previously been proposed in T. C. Patecell's United States Patent No. 3,635,273 to provide a safety roller for mounting on a vehicle wheel rim inside a pneumatic tyre in order to prevent total collapse of the tyre upon loss of inflation, thereby to obviate possible loss of control of the vehicle in such an event. An essential feature of this safety roller was that it was rotatable upon the wheel rim, thereby to accommodate the difference in circumference of the inside of the tyre tread and of the periphery of the roller which in prior art non-rotatable safety supports caused excessive heating of the tyre if the vehicle kept in motion after tyre deflation.

An improved form of safety roller is described in published United Kingdom Patent Specification No. 1,522,028 wherein the safety roller was rotatably borne in a bearing ring in the form of an annular channel Reference to Figure 2 of the above-mentioned Specification will illustrate various problems which are obviated or mitigated by provisions of the present invention. Firstly, to accommodate various tolerances in lateral dimensions, especially in the thickness of the tyre beads, the rubber spacer rings 23 and 24 were provided which were compressed in the illustrated assembly to take up the tolerances. It has been found that such spacer rings tend to become displaced when the tyre and wheel undergo severe lateral forces such as are produced upon hard cornering of the vehicle, the spacer ring on the outer side of the vehicle's cornering path being literally squeezed out of the annular gap between the tyre bead and the bearing ring 22 which in turn undesirably permits displacements of the tyre bead away from its proper seating immediately axially inwards of the wheel rim flanges. Secondly, there is only a shallow lip on the bearing ring 22 to accommodate lateral thrust when the vehicle runs with the tyre deflated, which causes excessive stress and wear of the safety roller 27 when the vehicle is cornering. Thirdly, difficulties have been encountered with the materials of the safety roller in that the safety roller may heat up considerably if the vehicle runs on a deflated tyre with consequential dimensional instability of the roller. Provision also has in practice to be made for suitable low friction between the safety roller and the bearing ring, as by installing therebetween a layer of polytetrafluoroethylene.

According to the invention, there is provided a tyre and wheel rim assembly having two axially-spaced-apart bead seats between and adjacent respective rim flanges, a pneumatic tyre including bead portions, the tyre being mounted on the rim with the bead portions seated upon said bead seats and abutting said flanges, and a safety roller arrangement, said arrangement including an annular bearing member located upon said rim between said bead portions, and a substantially rigid safety roller rotatably mounted upon said bearing member, and said assembly further comprising at least one elastomeric article in compression between said bearing member and a respective bead portion, said elastomeric article including an annular reinforcement rendering the elastomeric article substantially inextensible in a circumferential direction.

According to a second aspect of the invention, there is provided a safety roller arrangement for installation on the rim of a vehicle wheel and pneumatic tyre assembly, said roller arrangement comprising a substantially rigid annular roller and an annular bearing member therefor, said member resisting lateral movement of the roller when a lateral force due to cornering is applied thereto when the tyre is deflated. A roller-carrying surface of said bearing preferably has a transverse cross-section which is concavely curved and the mating surface of the roller when in contact with the roller-carrying surface being matchingly convex. Alternatively the transverse cross-section of the roller-carrying surface of said bearing member may be bi-conical, or it may have a substantially cylindrical mid-section with laterally outward sections each of which taper radially and axially outwards with respect to the wheel axis. Where the roller-carrying surface is transversely concavely curved as aforesaid, the radius of transverse curvature of the mating surface of the roller may be from substantially the same down to 50% (and possibly 20%, 15% or 10%) less than the radius of said roller-carrying surface, or where the roller-carrying surface is bi-conical or partially tapered as aforesaid, the corresponding portions of the mating surface of the roller may be similarly tapered or up to 10° or 15° more steeply tapered, in each case to give good mating between the bearing member and the roller even if the bearing member undergoes sufficient compression in installation as to cause transverse distortion thereof. The materials of one or both of said roller and bearing member may be of any suitable materials which will provide a low friction condition between the roller and the bearing member. Preferably the bearing member is a molybdenum disulphide impregnated nylon and the roller is of aluminium alloy for strength against mechanical loads. A roller of aluminium or other suitable metal has improved resistance to thermal distortion when supporting a moving vehicle with a deflated tyre, in comparison to a plastics roller. To facilitate installation of the roller inside a tyre having substantially inextensible beads and a considerable resistance to distortion thereof such as would be necessary to pass a larger diameter roller, the roller is preferably sub-divided into a plurality of arcuate sections provided with means for mutual fastening to form a complete ring, said sections preferably being substantially identical for convenience of manufacture and said plurality conveniently numbering three. The bearing

member may for similar reasons be sub-divided into the same or a different plurality of identical or different arcuate sections which however need not be provided with fastening means since the bearing member sections will be mutually located and held in position by the roller when the roller and bearing member are assembled. The wheel may be well-less, i.e. substantially cylindrical between the flanges, and further be laterally split into two or more annular sections in which two sections each bear a flange, the two or more sections being held together in use by a lock ring or a plurality of fasteners. Alternatively, the wheel may be a unitary wheel having a well enabling the substantially inextensible bead portions to be fitted over the circumferentially larger flanges, the wheel bead seats possibly being tapered with a taper which may lie in the range 5° to 15°.

Embodiments of the invention will now be described by way of examples, with reference to the accompanying drawings wherein:—

Figure 1 is a transverse cross-section of part of a tyre and wheel assembly,

Figures 2 and 3 are transverse cross-sections, to enlarged scales, of two alternative forms of spacer ring suitable for use in the assembly of Figure 1;

Figure 4 is an elevation of a safety roller assembly, and

Figures 5 and 6 are transverse cross-sections of alternative forms of bearing channel.

Referring first to Figure 1, a split well-less wheel is formed of two sections 10 and 12 each having respective flanges 14 and 16, the sections 10 and 12 being fastened together by suitable fasteners (e.g. nuts and bolts) diagrammatically represented at 18. A tubeless pneumatic tyre is mounted on the wheel. Only the bead portions 20 and 22 of the tyre are shown in Figure 1. The bead portions 20 and 22 include multi-strand steel cables 24 and 26 which render the bead portions substantially inextensible circumferentially. As may clearly be seen from Figure 1, the wheel rim is substantially flat, i.e. cylindrical, between the flanges 14 and 16. Substantially midway between the flanges 14 and 16 is an annular bearing member 28 extending substantially entirely around the periphery of the wheel. The member 28 has a concave bearing surface 30. Rotatably mounted on the member 28 is a substantially rigid annular roller 32 having a bearing surface 34 which is convex substantially to match and to mate with the bearing surface 30. To minimise overall weight of the roller 32 whilst providing adequate bearing surfaces, the surface 34 is made as wide as practicable as is the periphery 36 of the roller 32 while the intermediate portion is formed as a relatively thin web 38.

In the event that the tyre should become deflated for any reason, it will radially collapse under the load of the vehicle upon which it is fitted, and whereas this would usually result in rapid destruction of the tyre if the vehicle remained in motion, with the arrangement shown in Figure 1 the tyre will collapse only so far as to bring the radially inner surface of the tread (not shown) into contact with the roller periphery 36. The difference in the circumferential length between the inside of the tyre in the tread region and the periphery 36 is accommodated by the ready rotatability of the roller 32 upon the bearing member 28. Thereby also the roller 32 can be made sufficiently smaller than the inside of the tyre as to remain out of contact with the tyre during normal use thereof in the fully inflated condition. Thus the arrangement of Figure 1 has the two-fold advantage of not intefering with ordinary operation of the tyre in the fully inflated condition, but also, secondly, enables a vehicle to continue to be driven even if the type suffers substantial loss of inflation pressure.

A suitable material for the roller 32 is high-tensile aluminium alloy. A suitable material for the bearing member 28 is nylon impregnated with molybdenum disulphide (as sold under the trade name "Nylatron GSM" by the Polypenco Company). Such nylon has a low friction and is self-lubricating, which obviates the need for liquid lubricant. Any other suitable material could be employed for the bearing member 28. For suitable applications, e.g. light vehicles, the roller 32 could be formed of plastics material.

There are, as a practical matter of manufacture, tolerances in the axial spacing between the flanges 14 and 16, and variations between nominally identical tyres in respect of the lateral thicknesses of the bead portions. Therefore, in order laterally to secure the member 28 between the bead portions 20 and 22 despite the width of the member 28 being less than the axial spacing between the bead portions 20 and 22, two spacer rings 40 and 42 of resiliently compressible elastomeric material are located on either side of the member 28, the rings 40 and 42 having uncompressed dimensions chosen so that they are in substantial lateral compression in the illustrated assembly. In order to prevent the rings 40 and 42 being radially displaced out of their intended locations as shown in Figure 1, the rings 40 and 42 are made circumferentially substantially inextensible by the inclusion of respective cores 44 and 46 of substantially inextensible material of suitable tensile strength. The material of the cores 44 and 46 may be single or plural steel strands, conveniently standard tyre bead wires, or a plastics material.

In such circumstances as permit the member 28 to be offset from midway between the bead portions 20 and 22, in such case the bearing surface 34 and the periphery 36 of the roller 32 possibly being oppositely offset, only one of the rings 40 or 42 need be provided, the arrangement than being such that the member 28 would lie against one of the bead portions and the space between the other side of the member 28 and the other bead portion would be filled by the single ring which would as before be in substantial lateral compression. One or both of said rings 40 and 42 may be shaped to be adapted to the

uncompressed shape (i.e. the shape before assembly) of the bead portions 20 and 22.

Alternative forms of spacer rings are shown in Figures 2 and 3. In Figure 2, a spacer ring 60 is formed of laterally laminated annuli comprising a metal annulus 62 laterally bounded by two rubber annuli 64 and 66 disposed to lie on the laterally outer faces of the ring 60. It is to be noted that in the ring 60, rubber is not extended radially inwardly or outwardly of the metal annulus 62. In Figure 3, a spacer ring 70 is formed of adjoining annuli of metal 72 and rubber 74, with the rubber being formed into relatively thin layers radially inwardly and outwardly of the metal annulus 72 to give some measure of radial resilience over the inextensible portion of the ring 70.

Because the roller 32 is substantially rigid and the cables 24 and 26 render the bead portions 20 and 22 inextensible, it may be difficult or even impossible to insert the roller 32 as a single piece inside the tyre. Accordingly it is preferred to subdivide the roller 32 into a plurality of preferably identical arcuate sections. This is illustrated in Figure 4, where the plurality is three, though different numbers of sections may be chosen. The sections of the roller 32 are fastened together, after insertion into the tyre, by fasteners 48 passing through overlapping section ends. Figure 4 also illustrates how the roller 32 may be lightened by holes 50 which may not pass completely through the web 38. The member 28 is also divided into three (or another number) of identical arcuate sections for convenience of assembly (and economy of manufacture when the member 28 is cut from a block of material). The sections of the member 28 need not be provided with end fasteners since due to the concavity of the bearing surface 30 and the fitting of the member 28 radially inward of the roller 32, the roller 32 will hold together the sections of the member 28.

It will be seen from Figure 1 how the part-circular transverse concavity of the bearing surface 30 provides lateral location and guidance for the roller 32, with lateral loading being distributed over a substantial proportion of the width of the bearing surfaces 30 and 34. This provides improved load bearing and wear resisting characteristics in comparison to the upright channel sidewall of the prior art as exemplified by the aforementioned prior art Figure 2. Other forms of bearing members are illustrated in Figures 5 and 6. In Figure 5, the member has a bi-conical bearing surface. In Figure 6, the bearing surface of the member is similar to Figure 5 in that the laterally outer portions are conical, while the mid-portion is substantially cylindrical.

The bearing surface 34 of the roller 32 may have a smaller radius of curvature (or greater conicity) than that of the bearing surface 3 of the member 28 when the member is not laterally compressed, i.e. prior to installation inside a tyre, so that any distortion of the member 28 when subjected to substantial lateral compression as in the Figure 1 arrangement which might increase the concavity of the bearing surface 30, does not cause binding of the roller 32. The member 28 and the roller 32 are preferably dimensioned such that their bearing surfaces 30 and 34 are a suitable interference fit, so as to obviate spinning of the roller 32 during changes in rotational velocity of the wheel with the tyre fully inflated and out of contact with the roller periphery 36 but still permitting substantially unimpeded rotation of the roller 32 when the tyre becomes deflated.

The bearing member 28 need not be concave, i.e. have a bearing surface 30 with a laterally inner circumferential length less than that of the laterally outer portions, and the bearing surface may be convex, possibly to a substantial degree but preferably avoiding overall sphericity, such as to give lateral bearing support to the roller over a maximal area.

In Figure 1 the wheel has been exemplified as having a two-piece untapered well-less rim. The invention may equally be applied to one-piece wheels having wells and possibly tapered bead seats, with suitable adaptation, if necessary or desirable, of the shape of the wheel-contacting under-surface of the member 28 and suitable dimensioning of the inextensible rings 40 and 42. Yet a further type of wheel to which the invention may be applied is a wheel comprising more than two annular sections.

The invention may be applied to the wheels and tyres of all manner of vehicles, whether for road or cross-country use, to provide continued vehicle mobility in the event of and despite loss of tyre inflation pressure.

Claims

1. A tyre and wheel rim assembly comprising a wheel rim having two axially-spaced-apart bead seats between and adjacent respective rim flanges, a pneumatic tyre including bead portions, the tyre being mounted on the rim with the bead portions seated upon said bead seats and abutting said flanges, and a safety roller arrangement including an annular bearing member located upon said rim between said bead portions, and a substantially rigid safety roller rotatably mounted upon said bearing member, and said assembly further comprising at least one elastomeric article in compression between said bearing member and a respective bead portion, said elastomeric article including an annular reinforcement rendering the elastomeric article substantially inextensible in a circumferential direction.

2. An assembly according to Claim 1 including two said elastomeric articles each having a circumferentially-inextensible annular reinforcement, and each said article being located one on either side of said bearing member in lateral compression therebetween and the respective bead portion to provide lateral location of the bearing member against lateral displacement forces.

3. An assembly according to Claim 1 or Claim 2 wherein said safety roller arrangement

comprises a substantially rigid annular roller, said annular bearing member therefor resisting lateral movement of the roller when a lateral force due to cornering is applied when the tyre is deflated.

4. An arrangement according to Claim 3 wherein a roller-carrying surface of said bearing member has a transverse cross-section which is concavely curved and the mating surface of the roller when in contact with the roller-carrying surface being matchingly convex.

5. An arrangement according to Claim 3 wherein the transverse cross-section of the roller carrying surface of said bearing member is bi-conical.

6. An arrangement according to Claim 3 wherein the transverse cross-section of the roller carrying surface of said bearing member has a substantially cylindrical mid-section with laterally outward sections each of which taper radially and axially outwards with respect to the wheel axis.

7. An arrangement according to Claim 3 wherein the roller carrying surface of the bearing member is at least partially convex to provide lateral and skew stability for the roller bearing thereon.

8. An arrangement according to Claim 4 wherein the radius of transverse curvature of the mating surface of the roller is from substantially the same down to 50%, or 20%, or 15% or 10% less.

9. An arrangement according to either of Claims 5 or 6 wherein the corresponding portions of the mating surface of the roller have from a similar taper up to a 10° or 15° steeper taper.

10. An arrangement according to any preceding claim wherein the material of the bearing member is nylon which is impregnated with molybdenum disulphide.

11. An arrangement according to any preceding claim wherein the material of the roller is an aluminium alloy.

12. An arrangement according to any preceding claim wherein the roller is sub-divided, prior to assembly, into a plurality of arcuate sections provided with means for mutual fastening to form a complete ring upon assembly thereof.

13. An arrangement according to any of the preceding claims wherein the bearing ring is divided into a plurality of arcuate sections.

14. A reinforced elastomeric article for the assembly of any preceding claim, comprising a ring of resilient elastomeric material containing a core of substantially inextensible material, the ratio of total lateral width of elastomeric material to maximum lateral width of the core being at least 1.5:1, whereby the ring may be resiliently laterally compressed while retaining a substantially invariable circumferential length.

15. An article according to Claim 14 wherein said core is formed of one or more wires.

16. An article according to Claim 15 wherein said wires are of steel.

17. An article according to Claim 15 or Claim 16 wherein said wires are formed as stranded cables.

18. An article according to claim 14 wherein said core is a hoop of plastics material.

19. An article according to any of Claims 14—18 wherein the hoop is covered upon one or both of its radially inner and radially outer surfaces, by elastomeric material.

20. An article according to any preceding claim wherein the ring is formed as a laterally laminated structure of one or more annuli of substantially inextensible material and one or more annuli of elastomeric material the or each of which is disposed on one or respectively on each laterally outer-face of the ring.

21. A tyre and wheel rim assembly substantially as hereinbefore described with reference to Figure 1, or to Figure 1 as modified by any one of Figures 2, 3, 5, or 6, or to any of the foregoing in conjunction with Figure 4 of the accompanying drawings.

22. A safety roller assembly substantially as hereinbefore described with reference to Figure 1, or to Figures 1 and 4, or to Figures 1 and 5, or to Figures 1 and 6, or to Figures 1, 4, and 5, or to Figures 1, 4 and 6 of the accompanying drawings.

23. A reinforced elastomeric article substantially as hereinbefore described with reference to Figure 1, or to Figure 2, or to Figure 3 of the accompanying drawings.

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